

INTERNATIONAL EVALUATION COOPERATION SUBGROUP 7:
MULTIGROUP CROSS SECTION PROCESSING

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ABSTRACT: The chairmen of the ENDF/B, JEF, EFF, and JENDL evaluated data files adopted a proposal to develop a fine-group processed cross section library based on the "VITAMIN" concept. The authors listed above, with support from others, are participating in this project. The end result will be a pseudo-problem-independent fine-group cross section library generated from the latest evaluated data in ENDF/B-VI, JEF-2, EFF-2, and JENDL-3. Initial applications of the library will be for shielding, fast reactor physics, and fusion neutronics. Progress made to date will be discussed. (Cross sections, EFF, ENDF, JEF, JENDL, multigroup, radiation transport, shielding)

Introduction

A desirable outcome of international cooperation on evaluation of cross section data is the development of the corresponding processed libraries that can be used in radiation transport applications. The goal of Subgroup 7 is to produce processed multigroup libraries based on four major evaluated cross-section libraries. These include ENDF/B, developed in the United States, JEF, developed in Europe under NEA sponsorship, EFF, developed in Europe under ECC sponsorship, and JENDL, developed in Japan. A common set of specifications for processed data is suggested so that differences in preparation of libraries can be minimized. Data derived from the three evaluation sources will be available in common formats so that they can be incorporated into radiation transport analysis schemes with a minimum of difficulty. This will allow the assessment of the impact of various data sets on results and, if major discrepancies are encountered, provide additional guidance to the evaluation process.

The initial project will focus on producing a library based on the "VITAMIN" concept that has been used for libraries based on ENDF/B-IV (VITAMIN-C [1]), ENDF/B-V (VITAMIN-E [2]), and JEF-1 (VITAMIN-J [3]). This concept involves the generation of a fine-group pseudo-problem-independent cross-section library using the shielding factor method [4] to account for resonance self-shielding and temperature effects. The successful application of the libraries to a variety of problems, including shielding, fast reactor physics, and

fusion neutronics provides the impetus to select a similar approach for the first task undertaken by Subgroup 7.

Specifications

The suggested specifications for processed data are those used for VITAMIN-J, which were based on those developed earlier for VITAMIN-C and VITAMIN-E. Some details are provided in the sections that follow.

Energy Group Structures

The suggested neutron energy group structure includes the 175 groups in VITAMIN-J which span the energy range from thermal to 20 MeV. For photons, a 42 group structure extending up to 50 MeV is suggested. Both these energy structures contain as subsets the group structures of many broad group libraries in common use in the international community.

Weighting Spectrum

The suggested weighting spectrum for neutron groups is Maxwellian in the thermal region, and also includes a fission spectrum and a fusion peak. The three features are joined by "1/E" slowing down regions. For photon groups the weighting spectrum is "constant."

Resonance Reconstruction Tolerance

The suggested tolerance for reconstructing 0 Kelvin resonance data or linearizing is 0.1%.

Temperature Grid

The range of temperatures at which cross sections will be generated is between about 300 and 2100 Kelvin on a grid of 4 to 10 values.

*Operated by Martin Marietta Energy Systems, Inc., under contract DE-AC05-84OR21400 with the U.S. Department of Energy.

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Background Cross Sections

Ten or fewer background cross sections (including infinity and zero, essentially) will be used, representing a range of values expected in actual calculations.

Legendre Polynomial Expansion Order

The expansion order for neutron and photon scattering will be P_5 or higher.

Output Formats

Libraries will be available in a variety of standard formats from which problem-dependent libraries can be derived, primarily MATXS and AMPX.

Processing Codes

It is expected that the NJOY91 [5] processing system will be used for generating cross sections from ENDF/B-VI and JEF-2 and the PROF-GR system for JENDL-3. The NJOY processing system handles the ENDF-6 format which is used by ENDF/B-VI and JEF-2/EFF-2. Los Alamos developed and maintains NJOY with feedback from various users that rely on the Los Alamos National Laboratory (LANL) for help in supporting their processing efforts. ENEA/Bologna, ECN Petten, and Oak Ridge National Laboratory (ORNL) are working on GENDF to AMPX form translation.

Progress to Date

Processing tasks have already begun on evaluations from the major evaluated libraries. Specifications have been developed and procedures outlined for producing initial versions that will feed into the data testing activities supporting the ENDF/B, JEF/EFF, and JENDL evaluation projects.

JENDL

At the Japan Atomic Energy Research Institute, a JENDL Shielding Standard Library (JSSTD) has been produced [6] from JENDL-3 with 295 neutron and 104 photon groups. The neutron and photon groups from VITAMIN-J are subsets of JSSTD, with the exception of one neutron group boundary at 70 keV. The neutron weighting function is Maxwellian to 0.3224 eV and "1/E" at higher energies (because of the increased number of groups, weighting function energy dependence may be less important for JSSTD). The Legendre order is P_5 .

The temperature grid is 300, 600, 900, and 2100 K and the background cross-section grid is 0, 0.1778, and 1 to 10^6 in decades. Some 60 elements and isotopes have been completed using the PROF-GR system into an output format that can be processed by the MICROJ system to account for self-shielding and temperature effects.

JEF/EFF

The OECD/NEA Data Bank has issued a draft of Revision 3 of JEF/DOC-M15 [7] on standard energy group structures for benchmarking the newly released major evaluated libraries. Some 38 data sets had already been processed at 300 K and infinite background cross

section at IKE, Stuttgart, Germany, and PSI, Villigen, Switzerland, at the time of the Draft (Dec. 1990). The Draft also indicates a temperature range from 293.4 to 2100 K on a grid of 10 values and also a grid of 10 background cross sections from 10^{-3} to 10^{10} . Neutron data are to be produced at P_5 , photon data at P_8 .

The recommended processing codes are NJOY89.62 from Los Alamos, THEMIS from CEA/CEN Saclay, France (the physics modules in NJOY and THEMIS are identical) and MILLER from ENEA, Bologna, Italy [8]. Recommended output formats include GENDF, MATXS, AMPX (produced from GENDF with MILLER), and ANISN, all formats currently in wide use.

ENDF/B-VI

At ORNL, plans call for an ENDF/B-VI based library using the NJOY processing system. Some 37 data sets have already been processed with the VITAMIN-J group structures and weighting functions. Both neutron and photon data were generated at P_5 . The final version will contain a temperature grid of 300, 900, 1500, and 2100 K and a range of background cross sections from 0 to ∞ . The output format will be AMPX, which will be produced with MILLER or another module now under development at ORNL. Data from this initial set are to be used in CSEWG data testing of ENDF/B-VI.

Hanford Engineering Development Laboratory (HEDL) has agreed to provide ORNL with ENDF/B-VI pointwise tapes for over 200 nuclides at several temperatures.

The IAEA Nuclear Data Section plans to process the international Fusion Evaluated Nuclear Data File (FENDL) with NJOY according to VITAMIN-J specifications into GENDF output format. Since much of FENDL is based on ENDF/B-VI, discussions are underway with ORNL on sharing the processing chore.

Conclusions

Three major evaluated cross section data libraries have been released in recent months. After satisfactory review and testing it is anticipated that they will be released with no restrictions on their distribution. International cooperation in the evaluation arena is being actively pursued to help enhance the overall quality of these major evaluated data libraries. This era of cooperation extends into the cross-section processing field as plans are well underway to develop fine-group libraries that can be shared and used for benchmark testing of the evaluated data. The resulting data libraries will be distributed in standard formats via the NEA Data Bank, Saclay, France, and the Radiation Shielding Information Center (RSIC), Oak Ridge, Tenn., USA.

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